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Distortion in Photographic Images with the 13-inch Astrographic Object-glass of the Royal Observatory, Greenwich.

(*Communicated by the Astronomer Royal.*)

The measures of the reference stars of the *Eros* photographs have incidentally provided material for a determination of the optical distortion of the object-glass. The reduction of the measures was made in the same way as those for the *Astrographic Catalogue* (Greenwich *Astrographic Catalogue*, vol. i., Introduction, p. xliv), three arbitrary constants being adopted for each plate, viz. two to fix the centre and one for the orientation—the correction for scale value being obtained from the mean of all the photographs, and the corrections for differential refraction and aberration being computed. The differences between the photographic and the assumed positions of the reference stars derived from meridian observations appear as residuals between the standard coordinates computed from the assumed right ascensions and declinations and those obtained from the measures. As the same star frequently occurs on a number of plates, and may be near the centre on some and at some distance from it on others, comparison of the residuals shown at different distances from the centre may be made to determine the distortion of the field, the images within 40′ of the centre being sensibly unaffected by distortion.

For example, the star B.D. + 44°, 326 occurs on photographs obtained on 1900 December 13, 15, and 16. The approximate coordinates and residuals on the several plates are given in the following table:

No. of Plate.	Position of Instrument.	Date.	Approximate Coordinates and Distance from Centre.			Residuals (Tab.—Obs.)	
			x.	*y*.	*r*.	Δ*x*.	Δ*y*.
		1900.	″	″	′	″	″
5288	E	Dec. 13	−1000	−3100	55	+·05	−·06
89	E		,,	,,	,,	−·06	−·22
90	E		,,	,,	,,	−·11	−·15
94	E		,,	,,	,,	+·13	−·34
97	E		,,	,,	,,	+·10	+·07
99	W	Dec. 15	−2400	− 200	40	+·16	−·40
5300	W		,,	,,	,,	−·15	−·36
04	E		,,	,,	,,	−·06	−·36
06	E		,,	,,	,,	+·02	−·27
07	E		,,	,,	,,	−·34	−·28
08	W	Dec. 16	−3000	+1300	55	−·13	−·42

Date.	Weight.	Mean Residuals.	
		x.	*y*.
1900.		″	″
Dec. 13	5	+·02	−·14
,, 15	5	−·07	− 33
,, 16	1	− 13	−·42

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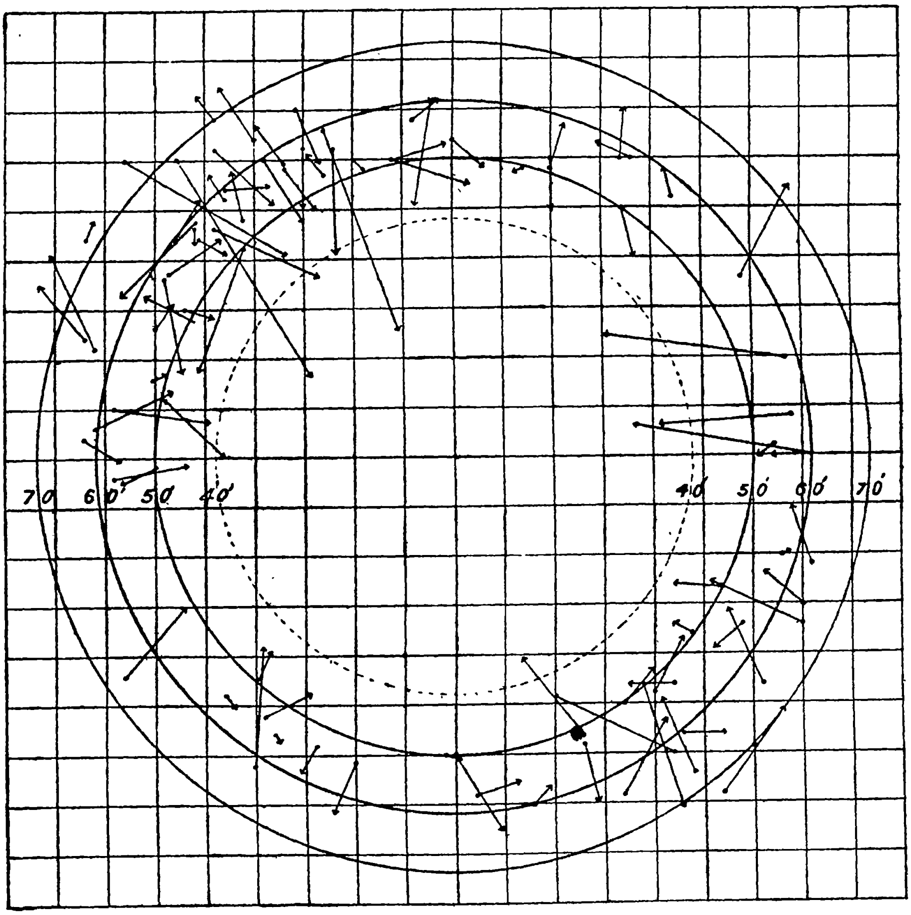
Images within 40′ of the centre have been considered as free from optical distortion, and the differences between the residuals have been treated as entirely due to this cause. By subtraction the following are obtained :

x.	y.	r.	Δx.	Δy.	No. of Photos.
		′	″	″	
−1000	−3100	55	−·09	−·19	5, 5
−3000	+1300	55	+·06	+·09	1, 5

The quantities Δx and Δy were tabulated for all the reference stars and plotted as shown in the diagram, and the values of Δr (the radial component) measured off.



Apparent Distortion on *Eros* Photographs.
Amount and direction of distortion indicated by the arrows. Scale 1^d = ″·2.

The values of Δr found between different limits of distance from the centre are shown in the following tables, the number of photographs on which the results depend being given in the second and third columns, the number in the third column referring to the comparison photographs on which the images are within 40′ of the centre.

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r 45′ to 50′.

Δr.	No. of Photos.
+′·15	3, 5
+·15	2, 6
+·11	5, 5
−·10	3, 5
−·25	1, 5
−·29	3, 3
−·03	7, 7
+·04	3, 2
−·07	1, 10
+·07	5, 5
+·08	7, 7
−·09	5, 7
+·10	5, 5
+·19	3, 6
+·06	1, 3
+·60	1, 1
−·10	5, 12
−·09	1, 4
+·02	5, 9
−·17	5, 3
+·11	2, 1
−·28	2, 6
+·07	7, 10
−·05	7, 8
−·01	7, 7
−·11	1, 7
+·08	3, 5
−·16	5, 3
−·07	2, 1
+·10	2, 1
+·07	3, 1
+·15	2, 1
+·04	3, 1
−·12	4, 4
+·14	4, 4
−·02	1, 4
+·19	1, 1
+·04	3, 4

r 50′ to 55′.

Δr.	No. of Photos.
+″·13	5, 1
+·18	3, 3
−·05	2, 1
−·11	5, 1
−·13	2, 3
−·19	1, 2
+·02	5, 5
+·02	5, 4
−·39	5, 6
+·33	1, 3
−·11	5, 3
−·28	3, 1
−·10	5, 3
−·04	6, 6
−·21	2, 3
+·19	3, 1
+·12	4, 1
−·05	6, 15
−·09	6, 3
−·04	2, 10
−·21	1, 1
+·04	2, 4
−·02	1, 6
+·49	1, 7
−·10	3, 1
+·22	4, 4
−·14	2, 3
−·18	3, 4
−·12	5, 1

r 55′ to 60′.

Δr.	No. of Photos.
−″·04	1, 2
+·20	5, 5
−·02	1, 5
−·13	1, 10
−·20	3, 6
−·22	6, 4
+·06	3, 11
+·19	4, 10
+·37	3, 4
+·07	1, 3
·00	3, 6
+·07	1, 3
+·12	6, 5
−·18	4, 13
·00	4, 8
+·03	6, 3
−·44	7, 4
+·13	2, 15
+·12	4, 1
+·02	3, 4
+·10	1, 2
+·02	1, 1
−·87	1, 6
−·39	4, 3
−·26	4, 3
−·11	4, 1
−·40	1, 3
−·12	3, 4
+·02	1, 1
−·30	3, 4
−·66	1, 3
−·56	1, 3

r 60′ to 65′.

Δr.	No. of Photos.
−″·47	1, 5
−·42	1, 1
+·26	1, 3
−·29	4, 2
−·30	5, 2
−·01	1, 2
−·43	2, 7
−·06	1, 4
+·28	3, 1
−·72	1, 3
−·15	1, 7
+·11	3, 4
−·15	1, 1
−·19	1, 1

r 65′ to 70′.

Δr.	No. of Photos.
− ″·35	4, 13
− ·20	1, 1
− ·24	2, 4
− ·41	3, 3
−1·02	2, 4
− ·31	3, 3
+ ·24	1, 1
− ·32	5, 1

r 70′ to 75′.

Δr.	No. of Photos.
+″·11	2, 5
−·74	7, 4
+·02	4, 1
−·12	2, 5

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The means in the above tables were taken in two ways: (i.) the simple mean, the result for each star being considered of equal weight; (ii.) the weighted mean, the weight being equal to the number of photographs on which the distorted images occur. The results are shown in the following table:

Limits of Distance.	Mean Distance from Centre.	No. of Stars.	Weight.	Mean Distortion. (i.)	(ii.)	Mean Discordance after Correction for Distortion.	Mean Discordance (Uncorrected).
′ ′	′			″	″	″	″
45–50	47·5	38	130	+·014	+·005	±·12	·12
50–55	52·5	29	98	–·029	–·044	·14	·15
55–60	57·5	32	93	–·106	–·083	·21	·20
60–65	61·6	14	26	–·181	–·166	·21	·27
65–75	70·0	12	36	–·262	–·354	·25	·34

The table given above shows:

(i.) At greater distances than 55′ from the centre star-images are in the mean sensibly distorted inwards.

(ii.) The amount of this distortion is subject to such variations depending on the magnitude of the star and exposure of the photograph that very little is gained by applying this mean correction. The means irrespective of sign of Table I. given in the last column of Table II. are sensibly the same as the discordances obtained after applying the mean distortion.

(iii.) The falling-off in accuracy due to photographic distortion is very marked beyond 55′ from the centre.

In the reduction of the *Eros* photographs no correction is being applied for distortion, and reference stars at greater distances than 55′ from the centre of the plate are not used except in one or two instances, where the number of stars is very small.

Magnetic Disturbances as recorded at the Royal Observatory, Greenwich, and their Association with Sun-spots. Third Paper. By E. Walter Maunder.

7. *Diurnal Inequality in Magnetic Disturbances.*

An examination of the two catalogues of magnetic disturbances contained in my first and second papers respectively (*Monthly Notices*, vol. lxv. pp. 2–34, and 538–559) shows a marked tendency in the selected times of commencement to favour certain hours of the Greenwich day. Table XIV. brings this tendency into prominence, and with it a curious difference between the catalogue in Table I. of the years 1882 to 1903 and that in Table IX. of the years 1848 to 1881.

Both catalogues agree in giving the commencement of at least